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(71)(72) Applicant and Inventor: KRØYER, Karl, Kristian, Kobs [DK/DK]; Le Vieux Moulin, 12, rue de la Libération, F-06520 Magagnosc (FR).

(74) Agent: LEHMANN & REE A/S; Grundtvigsvej 37, DK-1864 Frederiksberg C (DK).

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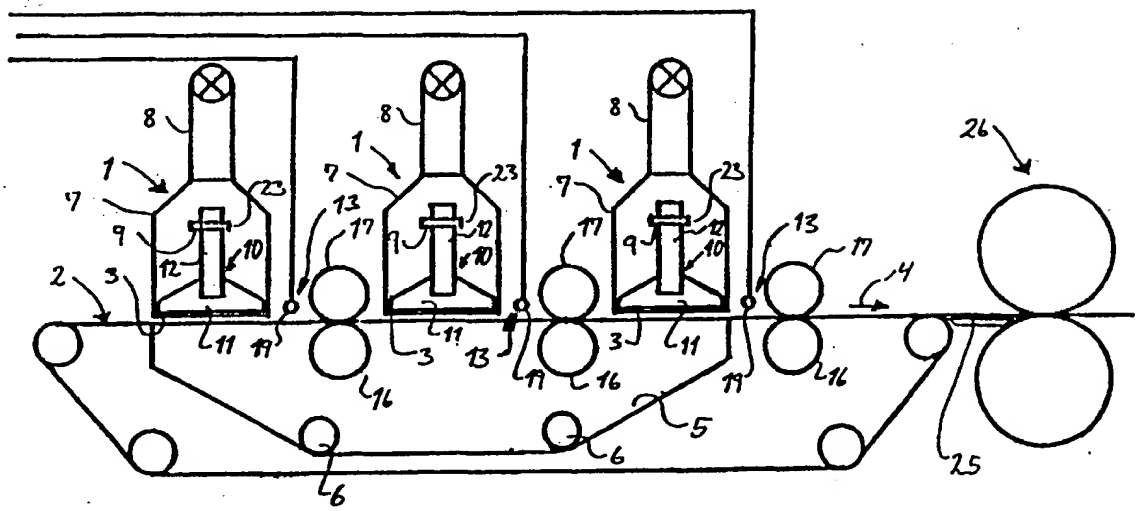

(57) Abstract

A plant for producing a dry-formed fiber product comprises a number of fiber distributors (1) arranged over a forming wire (2). Suction boxes (5) are arranged under the forming wire (2) opposite each fiber distributor (1). In order to allow the formation of a dry-formed multilayer fiber product on a forming wire (2), an adjustable moistening unit (13) and an adjustable compression unit (14) are arranged immediately after each fiber distributor (1). By changing the water supply via the moistening unit (13) and by changing the temperature and the pressure of the compression unit (14), different degrees of coherence of the interfaces of different layers are obtainable.

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A PLANT AND A METHOD FOR PRODUCING A DRY-FORMED FIBER PRODUCT

The present invention relates to a plant for producing a dry-formed fiber product comprising A) a number of fiber distributors each having a substantially plane bottom and being provided adjacent each other and arranged in such a manner that each one of them deposits a layer substantially simultaneously on one and the same forming wire, B) an endless forming wire being able to be advanced in a line situated under the bottom of the fiber distributors, and C) a suction device being arranged under the entire forming wire.

Dry-forming plants of the type described above are known, e.g. from the applicant's US patents No. 4,014,635 and No. 4,494,278; the applicant's Danish publications No. 153,530 and 162,845; and from the European patent No. 0,006,696.

In the plants for producing dry-formed fiber products according to the prior art the capacity is limited, being dependent on how fast the fibers are put onto the forming wire in such an amount that they will contact each other. Consequently, it is often necessary to operate at a relatively low speed of forming wire advancement and this limits the capacity at which the fiber products are produced. The plants known from the publications referenced above are particularly suited for producing thin single-layer fiber products, i.e. single-layer fiber products having a weight of down to 30 - 150 g/m^2. The fiber products thus formed will have identical properties throughout their thickness. In dry-forming techniques known from the above-mentioned publications it is known to place a number of fiber distributors above the forming wire in order to increase the production capacity by forming thicker layers. However, the products formed still remain coherent single-layer fiber products.

In wet-forming it is possible to make products having a weight of down to 11 to 20 g/m^2. Such low weight is necessary in order to obtain a soft product from the wet-forming process. Such products are used to a wide extent as products of the *Kleenex* type and as toilet paper, which will normally be made by a joining process in a special

joining station. Owing to the joining process, the real production rate of the wet-forming plant will be reduced to one half or one third depending on whether two or three layers are joined.

From wet-forming techniques it is known to produce single-layer fiber products on separate forming wires and subsequently take several of these separate single-layer fiber products to a joining station. The use of a joining station is expensive, however. It is possible to give different wet-formed layers different properties, but it is often very difficult to make the layers become coherent and form a homogeneous product. Furthermore, it is necessary for the wet-formed fiber layer to have a certain weight per square meter in order not to be broken when removed from the forming wire. Even when using the known wet-forming machines it is practically impossible to form multilayer products in which the individual layers have a weight of less than 10 to 12 g/m^2. Due to the wet forming the formation of hydrogen bonds making the product stiffer is unavoidable. There will necessarily be many occurrences of hydrogen bonds because very large amounts of water are used for distributing the fibers. Therefore, it is necessary in wet-forming techniques to form the so-called soft products from several layers of low weight by subsequent joining in an expensive joining station.

It is the object of the present invention to remedy the inconveniences of the known wet-forming plants and to describe a dry-forming plant that is suitable for the production of multilayer fiber products wherein the individual layers may be produced with a low weight and with the properties desired, and wherein it is possible to determine the degree of integration between the individual layers, which determines whether the finished product is to appear as one product, and in such a manner that the product appears essentially as a single-layer product without risk of delamination.

This is achieved according to the present invention by a plant of the type mentioned in the preamble which is characterized in that immediately after each fiber distributor, seen in the direction of advancement of the forming wire, an adjustable moistening unit and an adjustable compression unit are arranged.

The plant according to the invention is suitable for producing all types of paper articles such as napkins, sheets, table cloths, photocopy paper, filter media, and sanitary products, e.g. sanitary towels, panty liners and the like. Thus, it is possible to supply each of the fiber distributors from a separate defibrator/hammer mill. This makes it possible to use different types of fibers for different layers of the product. It is further possible to add various components in any layer, such as bicomponent fibers and superabsorbers, however, preferably bicomponent fibers in outer layers and superabsorbers in an intermediate layer of a three-layer product.

Thus, the fiber products made in the plant according to the invention are not only so-called "soft" products, such as napkins, toilet paper and the like. They comprise all types of paper including ordinary and thick paper products, e.g. thick packaging paper, photocopy paper, corrugated cardboard and the like. Dry forming according to the present invention allows soft products to be formed with a higher weight per square meter since only controllable and possibly very few hydrogen bonds occur. As the number of hydrogen bonds may be adjusted via the adjustment of the moistening unit, it is also possible to produce ordinary paper products, such as copy paper, in the plant according to the invention.

In this plant it is possible to moisten and compress the fiber layers formed in a controlled and monitored manner in order to control and monitor the degree of hydrogen bonds. Moistening takes place in the form of finely atomized water drops being applied by the moistening unit, which is situated immediately above the product. The moistening unit has a downward oriented opening so that the risk of moistening the subsequent compression unit comprising two cooperating compression rollers is avoided. In this manner the hand and feel, i.e. the softness of the product is controlled and monitored. The degree of layer integration may be controlled and monitored simultaneously.

In the plant according to the present invention all layers are dry-formed on one single forming wire. The application of the layers takes place almost simultaneously. In practice, the application of a subsequent layer takes place less than a second after the

formation of a preceding layer. Since immediately after each fiber distributor, seen in the direction of advancement of the forming wire, it is possible to moisten and compress the formed fiber layer in varying degrees, it is possible to form a multilayer fiber product in which a larger or smaller degree of integration between individual layers may be obtained so that the product may appear as a one-layer product without any risk of delamination or, like a multilayer product, of having separation between the different layers.

Thus, depending on the properties required from the formed multilayer fiber product, a larger or smaller amount of water may be applied. This provides the possibility of hydrogen bonds between the fibers. Likewise, it is possible to apply more or less heating via the compression unit, which also provides the possibility of adjustment of the pressure that is exerted in order to compress each fiber layer formed. Thus, with this plant it is possible to produce a laminated product wherein different kinds of lamination occur and consequently also different degrees of integration between the individual layers of the product.

As it is possible to obtain different degrees of lamination, it will be possible to enclose additives, e.g. superabsorbers, which are placed in an intermediate layer with a higher weight, e.g. up to approximately 100 to 200 g/m^2, between outer layers which are produced with a lower weight. In such a product at least one of the outer layers may, in a manner known per se, be formed by fibers mixed with bicomponent fibers so that a strong but flexible outer layer is obtained which, however, permits easy and rapid penetration of bodily discharges into an intermediate absorbent layer. Thus, the outer layers may be produced from hydrophobic fibers having penetration openings arranged to allow bodily liquids to penetrate at least one outer layer. The middle layer containing superabsorbers may be produced from hydrophillic fibers.

Since all layers are formed on one and the same forming wire, the use of an expensive joining station is omitted and it will be easy to control the process in such a manner that the fibers in the interfaces between the different layers are compressed but, however, with certain fibers projecting from the compressed surface. In this manner

it will be possible to provide bonds between fibers of different layers. Thus, the layers may be said to be integrated with or "grown" into each other in such a manner as to be sufficiently cohesive to avoid delamination.

Thus, upon removal from the forming wire, a multilayer product produced on a plant according to this invention may be taken through pairs of embossed rollers for the formation of sanitary products which are ready for use and which are produced with a lateral glue by means of a binding means application well-known per se and curing so that the products are ready for use after cutting the formed multilayer fiber band.

The plant may be operated at a high forming wire velocity, e.g. production rates of the finished product may be used which are considerably higher than the production rates of plants known today by simultaneous application from three fiber distributors. The forming wire is advanced at a velocity depending on the weight of the product and the fiber dosing capacity of the plant, typically between 100 and 600 m/min., preferably between 200 and 400 m/min. This is impossible in the known plants irrespective of their being wet-forming or dry-forming plants. At the same time different fiber qualities may be used in different product layers. Since each subsequent layer is applied, after less than a second, onto a more or less compressed fiber layer, it will be easier to place on the wire than if each layer were to be applied to separate bronze wires.

As a subsequent layer is applied almost simultaneously with a preceding layer, there is no risk of a beach effect. Thus, with a plant according to the invention it is possible to double or triple the production capacity of the plant. This is a very substantial technical progress since known dry-forming plants have had the disadvantage compared to wet-forming plants that the production rate was only a fraction of the production rate of wet-forming plants.

The invention also relates to a method for producing a sheet-formed fiber product in a plant comprising A) a number of fiber distributors each having a substantially plane bottom and being provided adjacent each other and arranged in such a manner that

each one of them deposits a layer substantially simultaneously on one and the same forming wire, B) an endless forming wire being able to be advanced in a line situated under the fiber distributors, and C) a suction device being arranged under the forming wire opposite the fiber distributors.

The method is characterized in that immediately after being placed on the forming wire each fiber layer is moistened and compressed before another fiber layer, if any, is formed on top of it.

With this method it is possible to increase the production capacity of a dry-forming plant considerably.

The method according to the invention involves the steps of feeding defibrated fibrous material from one or more defibrators, e.g. hammer mills, into the fiber distributors and therein, under the effect of stirring means, subjecting them to a movement across the bottom of the fiber distributor, said bottom being equipped with holes. It is considered most preferable to use one row of wings.

One may also use stirring means arranged in rows transversely of the direction of advancement of the forming wire, which means are disclosed for example in the applicant's US patent No. 4,494,278. The stirring means of each row may have partly overlapping action ranges. In this manner endless sausage-shaped bodies of loosely coherent fibers are formed which will move across the bottom in a direction transverse of the direction of advancement of the forming wire and which will release individual fibers during this movement, said fibers, having passed through the bottom under the influence of the suction from the suction device under the forming wire, are led onto the forming wire or onto the previously formed fiber layer on the forming wire.

In each of the subsequently used fiber distributors problems related to the release of short and ultrashort fibers are reduced because the previously formed layers on the forming wire tend to function as a filter retaining these short fibers in the formed fiber product.

The invention will now be explained in further detail with reference to the attached schematic drawings in which

Figure 1 illustrates a partially sectional view of an embodiment of a plant according to the invention;

Figure 2 illustrates a partially sectional view seen from the left side of the embodiment of a plant according to the invention illustrated in Figure 1; and

Figure 3 illustrates an enlarged fragmentary sectional view through a part of the plant shown in Figures 1 and 2.

Figure 1 shows a plant according to the invention and comprising three identical fiber distributors 1. The fiber distributors 1 are arranged in a row over an endless forming wire 2. Each fiber distributor 1 has a plane bottom in the form of a net 3 which is situated immediately above the forming wire 2. The nets 3 of the different fiber distributors 1 may have different mesh sizes. Thus, for certain products it may be advantageous that the middle fiber distributor 1 has a net 3 with smaller openings than the two other ones in order only to permit the passage of short fibers into an intermediate layer of the finished products. The forming wire 2 is advanced in the direction of an arrow 4. The finished fiber product 25 is led through a heating/embossing station 26.

A suction box 5 with suction openings 6 is located under the forming wire under the fiber distributors 1. Alternatively several suction boxes 5 may be used each of them being located under its own fiber distributor 1. This makes it possible to vary the underpressure under each one of the fiber distributors 1. This may be an advantage, e.g. in order to obtain sufficient suction effect at the last fiber distributor 1.

A housing 7 of each fiber distributor 1 communicates via a pipe 8 with a defibrator (not shown) for supplies of dry defibrated fibrous material. Inside the housing 7 the supplied fibers are distributed evenly all over the area using a known deflector system (not shown). Each fiber distributor 1 further comprises a number of stirring means 10

each comprising a stirring wing 11 and a vertical shaft 12. The shafts 12 are connected via drive wheels 9 and drive bands 23 to drive means in the form of an electric motor 24 (see fig. 2). Each stirring wing has a diameter of 800 to 1,000 mm and thus the five stirring wings 11 cover a band width of 3.0 to 3.2 m and will be arranged at a mutual shaft distance of 450 to 600 mm. The embodiment shown is a so-called compact unit using one row of stirring means 10.

However, it is also possible to use a different number of rows, e.g. 4, 8 or 12 if generally known fiber distributors are used, e.g. as described in some of the above referenced patent publications.

Located immediately after each fiber distributor 1, as seen in the direction of advancement 4 of the forming wire 2, are a variably adjustable moistening unit 13 and a variably adjustable compression unit 14.

The moistening unit 13, which is seen most clearly in Figure 3, consists of a water atomization lance 19 having a downward oriented gap 20 and being located closely over the surface 21 of the formed fiber layer 22 and emitting finely atomized water drops. These fine water drops are emitted via the downward oriented gap 20. As the lance 19 is located closely over the surface 21 of the fiber layer 22, there is no risk that the water will hit the compression unit 13. The water drops are sucked down into the fiber layer by the suction box 5 located under the forming wire. The lance 19 is connected via a pipeline 15 with a supply of liquid (not shown). The capacity of the moistening unit 13 is adjustable so that it may emit a water amount corresponding to 0 to 50% of the amount of fibers deposited by the fiber distributor located in an immediately preceding position. This adjustment of the capacity may be accomplished manually or automatically by means of control means connected with the fiber distributor 1.

Each compression unit 14 comprises two compression rollers 16, 17. At least the roller 17 is connected with heating means (not shown) which are adjustable for heating the roller to a temperature of between 50 and 200°C or higher. The two compression

rollers 16, 17 are mutually connected by means of adjustable tightening means (not shown), e.g. in the form of hydraulic cylinders. In this manner the degree of compression may be adjusted for a fiber layer 22 formed by an immediately preceding fiber distributor 1.

As has been explained previously, it will be possible to obtain different degrees of integration between the individual layers using identical fiber distributors by varying the water supply from the moistening unit and by adjusting the temperature and tightness of the compression unit.

The plant shown in Figure 1 may be used for producing a triple layer fiber product in the form of a sanitary product, e.g. a sanitary towel. The first fiber distributor is supplied with hydrophobic fibers for the formation of a thin outer layer of the sanitary product. This outer layer may for example have a weight of between 10 and 200 g/m^2. Hydrophillic fibers, e.g. containing superabsorbers, may be supplied into the middle fiber distributor 1. The layer formed by the middle fiber distributor is applied on top of the previously formed and compressed layer. The hydrophillic fibers may be applied in a layer having a weight of up to 100 to 200 g/m^2 including superabsorbers. The last fiber distributor 1 may form a layer of hydrophobic fibers corresponding to the layer formed by the first fiber distributor.

Bicomponent fibers may be used for the two outer layers in order to obtain the greatest possible strength in the two layers when the finished sanitary product is subjected to a subsequent curing known per se.

The superabsorbers present in the hydrophillic fibers of the middle layer will be enclosed in the middle layer and there will be no risk that the powder-shaped superabsorbers will fall out before use. Owing to the bonds formed in the interfaces of different layers, the superabsorbers will remain in the middle layer. Alternatively, the superabsorbers may also be provided in several of the layers formed or in interfaces between layers.

Figure 2 shows a plane view of the plant shown in Figure 1. Thus, a compact unit is used for fiber distributor 1. The plant is connected with a defibrator (not shown) which is not located in the immediate vicinity of the housing 7. The housing 7 of the fiber distributor 1 is thus supplied with fibrous material via the pipes 8. This fibrous material is distributed evenly throughout the housing 7 by means of a deflector system (not shown). In this embodiment the defibrators/hammer mills will be located in a separate room so that noise nuisances are reduced in the vicinity of the dry-forming plant itself.

In the embodiments shown it is possible to produce a dry-formed multilayer fiber product without having to use joining stations. Thus, the multilayer fiber product may be produced with the required thickness and type of individual layers in a relatively uncomplicated manner and at lower cost than is the case when using joining stations. The invention further makes it possible in a simple manner to vary the degree of infiltration or cohesion appearing between the different layers of the product. Thus, different properties may be established in different layers without the risk of delamination of the finished product.

Although the figures illustrate plants having three fiber distributors 1, it will also be possible within the scope of the present invention to use fewer or more fiber distributors depending on the number of layers required in the finished product.

CLAIMS

1. A plant for producing a dry-formed fiber product comprising A) a number of fiber distributors each having a substantially plane bottom and being provided adjacent each other and arranged in such a manner that each one of them deposits a layer substantially simultaneously on one and the same forming wire, B) an endless forming wire being able to be advanced in a line situated under the bottom of the fiber distributors, and C) a suction device being arranged under the entire forming wire, c h a r a c t e r i z e d in that immediately after each fiber distributor, seen in the direction of advancement of the forming wire, an adjustable moistening unit and an adjustable compression unit are arranged.

2. A plant according to claim 1, c h a r a c t e r i z e d in that said compression unit comprises pairs of rollers having adjustable heating means and adjustable tightening means, and in that the moistening unit is provided with adjustable water nozzles across the width of the band being formed.

3. A plant according to claim 1 or 2, c h a r a c t e r i z e d in that each of said fiber distributors is connected to a separate fiber supply.

4. A plant according to any one of the preceding claims, c h a r a c t e r i z e d in that each of said fiber distributors is arranged to be able to deposit a fiber layer having a weight of between 10 and 200 g/m^2.

5. A plant according to any one of the preceding claims, c h a r a c t e r i z e d in that each of said moistening units is arranged to be able to supply an amount of water of 0 - 50%, preferably 10 - 25%, of the weight of the fibers deposited by the immediately preceding fiber distributor, and in that the compression unit is arranged to be heatable up to a temperature of between 50 and 200°C.

6. A method for producing a band-formed fiber product in a plant comprising A) a

number of fiber distributors each having a substantially plane bottom and being provided adjacent each other and arranged in such a manner that each one of them deposits a layer substantially simultaneously on one and the same forming wire, B) an endless forming wire being able to be advanced in a line situated under the fiber distributors, and C) a suction device being arranged under the forming wire opposite the fiber distributors, c h a r a c t e r i z e d in that immediately after being placed on the forming wire each fiber layer is moistened and compressed before another fiber layer, if any, is formed on top of it.

7. A method according to claim 6, c h a r a c t e r i z e d in that an amount of fibers of between 10 and 100 g/m^2 is applied in each layer, and in that an amount of water of between 0 and 50%, preferably 10 - 25%, of the fiber weight of a layer is applied.

8. A method according to claim 6 or 7, c h a r a c t e r i z e d in that said compression rollers are heated to a temperature of between 50 and 200°C.

9. A method according to any one of claims 6 to 8, c h a r a c t e r i z e d in that in one or more of the layers superabsorbers are used between the layers.

10. A method according to any one of claims 6 to 9, c h a r a c t e r i z e d in that the forming wire is advanced at a rate of between 200 and 400 m/min.

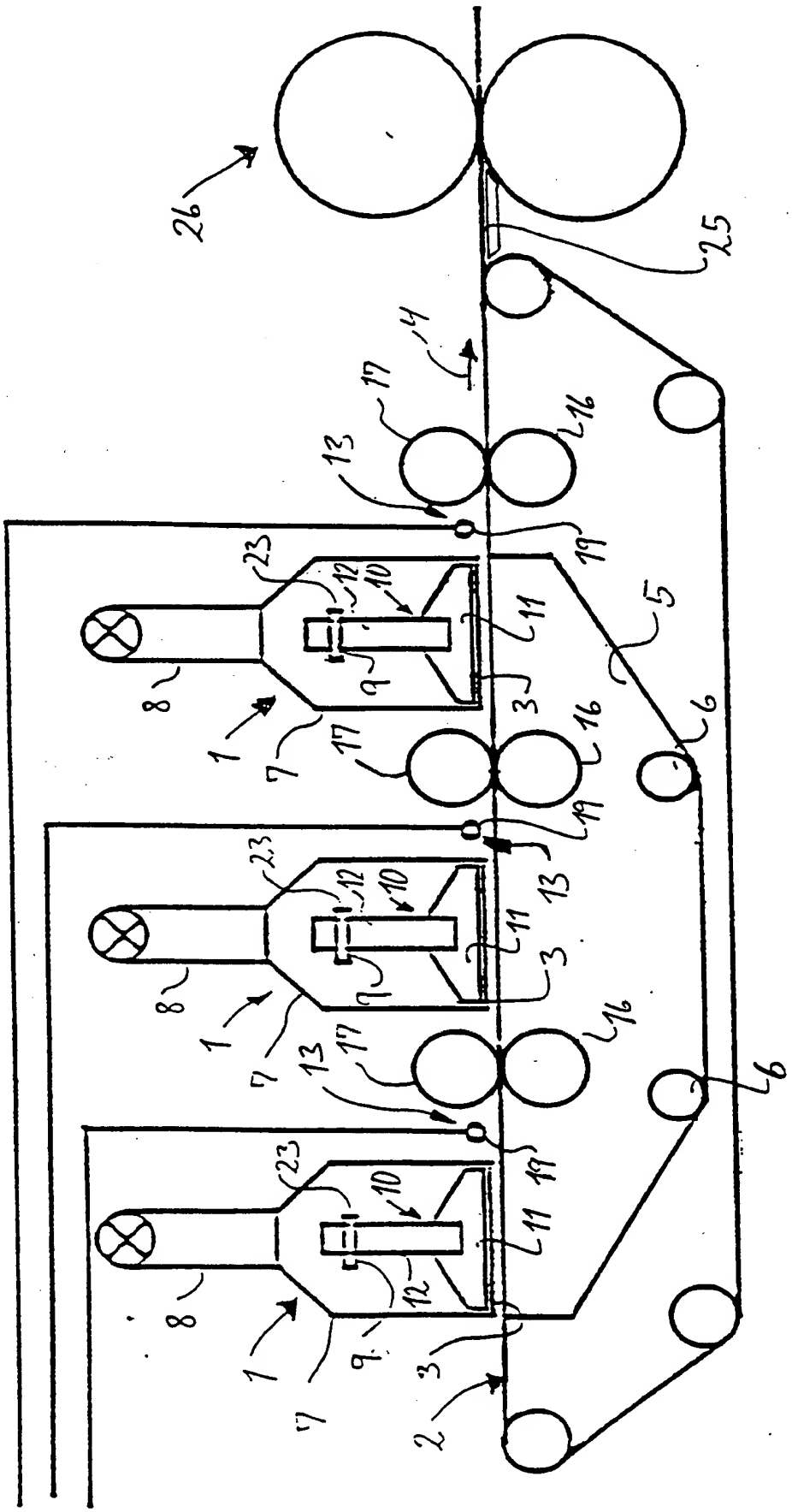

FIG. 1

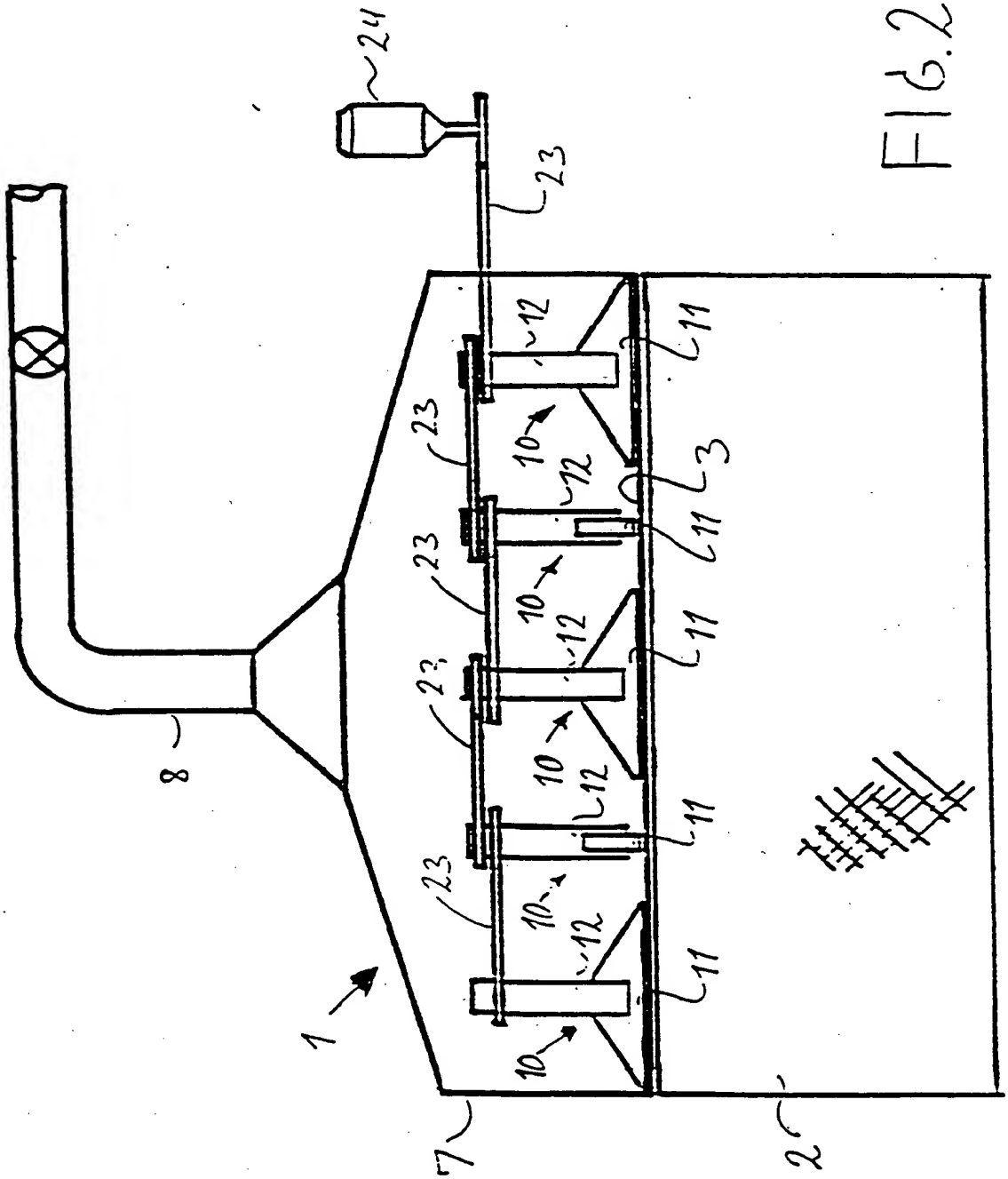

FIG.2

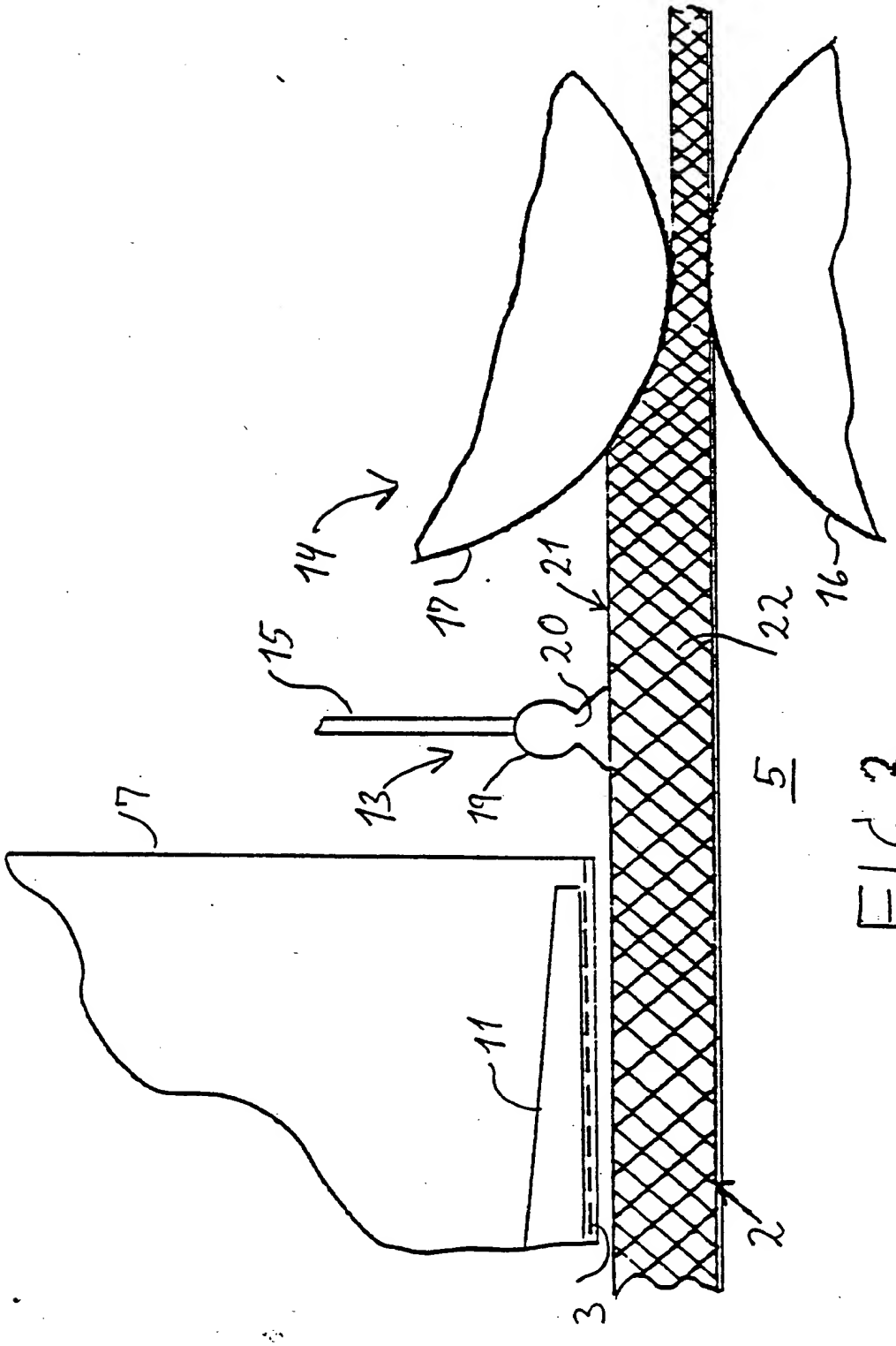

FIG.3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 95/00074

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: D21H 27/42, B32B 31/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: D21H, A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4071651 (DENIS RAYMOND HICKLIN ET AL), 31 January 1978 (31.01.78), column 2, line 19 - line 56, claim 1 --	1-10
A	US, A, 4011034 (HAROLD GEORGE CURRY ET AL), 8 March 1977 (08.03.77), column 3, line 16 - line 25, claim 1 --	1-10
A	CH, A5, 574539 (KARL KROYER ST. ANNE'S LIMITED), 15 April 1976 (15.04.76) -- --------	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
1 June 1995	12-06-1995
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Barbro Nilsson Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

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Information on patent family members

03/05/95

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PCT/DK 95/00074

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